TRANSIT NEW ZEALAND
SH1 AVALON DRIVE BYPASS

Stormwater Management System
Project Review

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Figure

1 Introduction

Opus has been commissioned by Transit New Zealand to provide construction and design information on the stormwater system for Avalon Drive Bypass project.

This report is part of the Final Stormwater Management Standard and Valuation Review undertaken by Transit New Zealand.

Figure 1 is attached to this report to locate the different names of place, stream, road and area for this project.

2 Environmental Factors

2.1 Description of catchments

2.1.1 Terrain

The catchment area is located in a peri-urban area – the roading project is located between a commercial and industrial area and a railway and is also crossing the Waitawhiriwhiri gully (urban type gully).

2.1.2 Area

The catchment area may be divided into two topographical areas.

- The flat areas of the ex-railway yards and ex-rough pasture to the North of Forest Lake Road. These areas are bounded by Avalon Drive commercial in the West, the railway in the East and Crawford Street in the North;
- The areas to the South of Forest Lake Road and surrounding the Waitawhiriwhiri Stream Gully. These areas are bordered by the rail corridor to the East and the gully to the West.

The catchment, prior to construction was approximately 34ha included 19ha of railway yard and 15ha of grassed land.

2.1.3 Topography

In general the catchment is flat with ground levels between RL 34m and RL 34.5 with the only major feature being the deeply incised Waitawhiriwhiri Stream gully near the Southern end.

2.1.4 Drainage Features

The rail corridor is separately drained to the North via a substantial system of subsoil and piped drains. The new bypass drainage is handled entirely separately from the rail corridor system.

For the area North of Forest Lake Road, a new stormwater system is required whereas to the South existing drainage culverts to the Gully are utilised.

2.1.5 Geotechnical Limitations and Opportunities

Ground water level is variable within the catchment; with ground water level being within 1 to 2m below the ground surface at the northern end of the project and around 12m depth adjacent to the gully.

Soakage was deemed infeasible due to soil type and the volume of stormwater to be discharged.

2.1.6 Soils

Soils are heterogeneous within the catchment, with silts, silty sands or sand.

2.1.7 Erosion Potential

Due to the flat terrain of the general area, the risk of erosion over most of the project length is low.

However in the Waitawhiriwhiri Stream Gully potential for erosion is high, due to local steep embankments in the vicinity of a bed stream.

Gabion baskets and mattresses were used to line parts of the existing stream to protect the stream banks from erosion, around the new culvert inlet.

2.1.8 Flooding

There are no flooding issues except the low lying rough pasture to the North which was subject to ponding during rainfall.

Some of the commercial properties backing onto the bypass discharged stormwater into the ex-rail corridor (now bypass) and this resulted in the need for additional drainage.

In the gully area, behind the 5 major culverts of the stream, there are no floodable buildings.

2.1.9 Design Storm Event

The Design standard adopted for reticulation sizing was the 5-year ARI (Average Recurrence Interval) event without surcharge of the reticulation above ground level and the 50-year ARI for overland flow.

The storm water pond has been designed for the 50-yr 24-hr event.

2.1.10 Vehicle kilometres travelled at time of opening

The traffic flow on SH1 is around 25,000 vehicles per day. The Avalon Drive is 2km long so the traffic flow is around 50,000 vehicle kilometres per day.

2.1.11 Discharge Points

All the northern extent of the project drains into the pond via a piped system. In turn, the pond discharges to the existing deep Avalon Drive stormwater main and eventually into the Waitawhiriwhiri stream.

The southern part of the roading project will discharge into the Lincoln street main which ends into the Waitawhiriwhiri stream near the Rifle road and Lincoln street intersection.

2.1.12 Catchment Classification

(Refer to the Transit document: NSHS-2007)

The roading project can be classified as peri-urban, according to the SHS-2007 document.

The surroundings have diverse land uses such as commercial, industrial and residential – the bypass road is adjacent to the rail corridor and crosses a gully.

2.2 Sensitivity of receiving environment

This section is referred to the Transit Document, 2007: "Identifying Sensitive Receiving Environments at Risk from Road Runoff, Land Transport New Zealand Research Report 315".

2.2.1 Schematic of SRE rating framework

The proposed method is based on a hierarchical system whereby the receiving environment (RE) is sequentially classified according to three attributes:

- Physical 'type sensitivity' (depositional vs. dispersive),
- Ecological values,
- Human use values (including cultural values).

Within each of the above attributes, the receiving environments are classified as being of 'high' (H), 'medium' (M), or 'low' (L) sensitivity and assigned a numerical score accordingly.

The overall sensitivity rating for each receiving environment is calculated by adding the scores for the type sensitivity, ecological value and human use value. The

sensitivity rating is grouped under three broad categories, based on the total score, with high ratings indicative of high sensitivity, as follows:

- High sensitivity (high potential risk from road runoff): Total score >40
- Medium sensitivity (moderate potential risk from runoff): Total score 20-40
- Low sensitivity (low potential risk from road runoff): Total score <20

2.2.2 Sensitivity of receiving environment – Avalon Drive Bypass

The design of the stormwater Avalon Drive Bypass is separated in two catchment areas:

- North of the Forest Lake Road and,
- South of the Forest Lake Road and surrounding the Waitawhiriwhiri Stream gully

The receiving environment of stormwater coming from both of the Avalon Drive Bypass catchment areas is the Waitawhiriwhiri stream.

Sensitivity

The Waitawhiriwhiri stream is an urban stream highly modified. It has been channelized over years and many culverts have been installed. The stream forms part of the gully system within Hamilton which drains most of the developed areas. The gully has been infilled by previous development and the main stream flow now carried by large culverts.

The Waitawhiriwhiri stream discharges into the Waikato River.

For these reasons, the Waitawhiriwhiri stream is to be qualified as dispersive and has a low sensitivity value (Score: 5).

Opus report, April 2005: "Avalon Drive Bypass, Stormwater Proposal, Resource Consent Applications and Assessment of Environment effects" detailed the ecological and human use values for the Waitawhiwhiri stream.

Ecological value

Biological: Typically macro invertebrate communities of Hamilton's streams are dominated by pollution tolerant taxa. Short finned eels are the predominant species in Hamilton's streams, including the Waitawhiriwhiri Stream.

Temperature: High water temperatures are found in the stream during summer months, consistently above 20°C and often approaching 25°C (Wilding 1998).

Metals: In many places the substrate is coated with iron floc.

The Waitawhiriwhiri stream has a low ecological value (Score: 5).

Part of the gully is in the ownership of Hamilton City Council and is included in the Gully Reserves Management Plan (2000), which looks at enhancing the ecological, recreational and cultural values of the gully systems.

The project works have resulted in the removal of significant debris and invasive species from the gully and the end result has seen a significant improvement in the gully value, however inflows from upstream residential developments are still of poor quality.

Human use value

Detailed historical, archaeological and cultural investigations were carried out and no sites within the immediate project area were identified; however the gully area is of significance to the local Iwi, Ngati Wairere, for fishing and eeling purposes.

Iwi representatives have been consulted, and a protocol is to be followed in the event of the discovery of any remains, artefacts, taonga or koiwi has been developed by the Iwi for this project.

No other human use has been reported.

The Waitawhiriwhiri stream has a moderate human use value (Score: 5).

Overall sensitivity rating (Sum)

Attributes	Sensitivity	Score
Sensitivity	Low	5
Ecological Value	Low	5
Human Use Value	Moderate	5
Overall Sensitivity Rating (Sum)	**Low**	**15**

Based on the scores found for each attributes (less than 20), the Waitawhiriwhiri stream has a low overall sensitivity rating.

3 Designed Solutions

This section provides a brief description of:

- The design philosophy,
- The stormwater management devices method used for the design, positioning and construction,
- Cost and time.

3.1 Design philosophy

3.1.1 Objectives

Assumptions

Opus objectives for developing the stormwater design were:

- To comply with the Hamilton City Council stormwater design standards,
- To comply with the existing Hamilton City Council system capacity; so the new stormwater design will not result in any adverse effect on it.
- To ensure a less overland flow into neighbouring properties
- Not to increase runoff without mitigation,
- To improve stormwater quality discharging into the existing systems

The design standard adopted for reticulation sizing was the:

- 5-year ARI (Average Recurrence Interval) storm event for pipe system design
- 50-year ARI storm event for overland flow

Source

- Avalon Drive Bypass: Design Philosophy Statement Report, Opus April 2005
- Hamilton City Development Manual 2000. Hamilton City Council, New Zealand

Options analysis

The original scheme concept for the road was:

- To convey stormwater from the Rotokauri Road roundabout and surrounding area including three commercial development sites to a medium size (8,700m3) detention pond
- To convey all the stormwater from the detention pond and the road reserve south to Forest Lake Road by a deep gravity pipeline to the Waitawhiriwhiri Stream.

The revised design of the stormwater Avalon Drive Bypass is separated in two parts:

- North of the Forest Lake Road and,
- South of the Forest Lake Road and surrounding the Waitawhiriwhiri Stream gully

North of Forest Lake Road, the main part of the stormwater of the undrained land, is drained by pipes, to a large attenuation pond (13,400m3) with discharge from the pond to the existing Avalon Drive stormwater pipeline with a 300mm diameter pipe, which is not significantly more flow than from the un-drained land. The remaining un-drained stormwater will be connected to the existing system without significantly flow modification.

South of Forest Lake Road and surrounding the Waitawhiriwhiri stream, there is no nett increase in runoff (i.e. the impermeable surface area is equivalent). Whilst the road area has increased, the removal of large commercial buildings and parks areas has mitigated this effect. Only the existing Waitawhiriwhiri stream culverts under the railway have been extended.

3.1.2 Criteria

Water Quality

Groundwater:

The effect of the stormwater pond on the groundwater is considered minor compared to the effect of the site being made impervious, which was lower the local groundwater table to a small degree.

Pollutants/ Suspended Solids:

Use of the stormwater retention pond will assist in retaining pollutants and suspended solids.

Also, the storage pond provides an opportunity to trap any accidental spills of substances that occur on the new Avalon Drive. In the event that such a spill occurs, the pond outfall can be blocked off until contaminated water and sediment are removed.

Water Quantity

Opus objective for the water quantity criteria was to reduce to effect of the peak run-off for the North of Forest Lake Road. A pond was built to mitigate the increase of impervious areas.

Effect on the Rotokauri/Avalon Drive roundabout:

There is no anticipated change in impervious area at the Rotokauri Road roundabout. The extra impervious area of roading is balanced by the drainage of the pavement of Avalon Drive to the south of the roundabout to the large retention pond, which is large enough to hold the 50 year Average Recurrence interval 24 hour storm.

Effect on the Norton/Avalon Drive roundabout:

There is no anticipated change in impervious area at the Norton Road roundabout. The only extra impervious area of roading is balanced by the demolition of a building and car park immediately north of the roundabout, and replacement with a grassed area.

Stream channel erosion criteria

North of Forest Lake Road,

A large detention pond (13,400m3) was designed with a discharge to the existing Avalon Drive stormwater pipeline through a 300mm diameter pipe. The pond is large enough to hold the 50 year Average Recurrence interval 24 hour storm.

South of Forest Lake road and surrounding the Waitawhiriwhiri stream,

There is no anticipated change in impervious area. The stream channel erosion criteria is not applicable for this area.

3.1.3 General

The benefits of the existing large storage pond as part of the system include:

- Reduction in peak runoff flows to the receiving environment;
- Improved stormwater quality discharging into a natural waterway, in particular a reduction in suspended solids concentrations and in turn a reduction in pollutants.

3.1.4 References

References used for the stormwater drainage proposal report and stormwater design report:

- Stormwater Disposal Report 15: Waitawhiriwhiri Stream Improvements (October 1976). Hamilton City Council, City Engineers Department, New Zealand.
- Hamilton City Development Manual 2000. Hamilton City Council, New Zealand
- Erosion and Sediment Control- Guidelines for soil Disturbing Activities Tech Report 2002/01. Environment Waikato, New Zealand
- Horner and Mars (1985) Assessing the Impacts of Operating Highways on Aquatic Ecosystems, Surface Drainage and Highway Runoff Pollutants. Transport Research Record 1017, Transportation Research Board, National Research Council.
- T. K. Wilding (1998) The State of Hamilton Streams, Environment Waikato, New Zealand
- Stormwater Management Devices: Design Guidelines Manual (May 2003) Auckland Regional Council Technical Publication 10.

3.2 Stormwater management devices methods:

3.2.1 Erosion and Sedimentation control

Design statement

Stormwater management for large earthworks projects rely on:

- Diverting clear water before it flows onto the disturbed area and discharging this water untreated;
- Conveying brown water in channels (often lined) and treating the water before discharge;
- Minimising brown water volume by minimising the disturbed area and hydromulching all erodable surfaces 'sealing' disturbed surfaces as early as possible.

Prior to construction, sediment and erosion control measures must be designed and implemented in accordance with the Erosion and sediment control guidelines (Environment Waikato, 2002).

Avalon Drive Bypass

Sediment and erosion control measures have been implemented by contractors on site in accordance with the Erosion and sediment control guidelines (Environment Waikato, 2002).

A site visit dated 14 May 2008 provided visual evidence of some measures to control sediment and erosion for the pond catchment and the south of Forest Lake Road in the Waitawhiriwhiri Stream.

The pond catchment is flat and the ash soils are well protected from erosion by the surfacing of plantings. Likewise, the rock mattress is protected the batters from erosion. Measures introduced to control erosion are shown with the two photos below:

The construction of the embankment in the south of Forest Lake Road represented a period of high risk in terms of discharge of sediments to the watercourse. Measures introduced to minimise these risks are shown with the four photos below:

Mulching (Protective layer of straw)

Silt Fence

Stabilisation by revegetation and Gabion basket

Silt Fence

Fibrous geotextile fabric (coconut fibre matting)
The geotextile allows to reinstated batter before vegetation is established.

3.2.2 Operational stormwater management (permanent)

i. Collection

Stormwater will be collected through kerb, channel and catchpit in accordance with Hamilton City Council Standards.

Position and construction depend on site conditions.

ii. Conveyance

Drainage design catchments were drawn based on survey data and existing stormwater systems locations and levels.

Stormwater pipeline design was modelled using Infoworks CS.

iii. Attenuation

The minimum required pond volume was calculated through the formula:

V_{tot}= *CAR*

In which

V_{tot} = Volume minimum required pond

C = Runoff Coefficient

R = Rainfall event in m

A = Area of the catchment in m^2

The stormwater pond has been designed for the 50yr-24hr event. In longer duration events, the existing HCC system will not be at full capacity, and will therefore make continuous drainage of the pond to the existing HCC system possible. This continuous discharge from the pond ensures that storage of the entire runoff volume in the pond is not required. The weighted average C-factor representative of the entire catchment is 0.8.

Therefore the critical duration that determines the required storage volume in the pond has been set at 24 hours. The total rainfall depth during the 50-24hr storm is 125mm.

The total catchment area draining to the stormwater pond is 13ha.

iv. Treatment

Stormwater coming from areas that are not drained to the large stormwater retention pond will be treated by passage through sediment traps before the water flows into the Waitawhiriwhiri via the existing stormwater drainage system.

The stormwater inflow to the pond is likely to have a low suspended solids content. In any case, a silt trap has been designed to reduce the necessity for maintenance dredging of the pond.

The pond itself will improve stormwater quality by reducing significantly suspended solids concentration and by retaining pollutants.

3.3 Cost

3.3.1 Resource Consents

The costs of the Stormwater related Resource Consents were:

- $5,128 for the Consent Application and Processing Fees from EW,
- $9,723 of Professional Fees for Consents application and documentation.

So a total of $ 14,851, including AEE, council Fees, other professional services

3.3.2 Building and other consents

Not applicable to stormwater. No building consents required for ponds and outlet structures.

3.3.3 Final Design

The final design cost of the Stormwater system including surface drainage design, culvert systems, ponds and outlet was estimated at $ 78,000

3.3.4 Construction

i. Collection

The construction cost for collection is $1,100,000 (rounded)

ii. Conveyance

The construction cost for conveyance is $1,660,000 including $435,000 for works linked to the culvert extension on the Waitawhiriwhiri stream.

iii. Attenuation

The pond will act both as an attenuation and a treatment device. Thus the presented cost is for both actions.

The construction cost for attenuation and treatment is $760,000, including $130,000 for temporary erosion and sediment control.

iv. Treatment

See above.

3.3.5 Monitoring Costs

(Including surveillance, inspection and performance)

i. Construction

Monitoring costs during construction are $14,500 (to date).

ii. Operational

Operational monitoring costs have been excluded from consideration in this report as they are unknown at this time and will be determined afterwards. However they are expected to be less than $1,000pa.

3.3.6 Operation and maintenance estimated annual cost

Operational and maintenance costs have been excluded from consideration in this report as they are unknown at this time and will be determined afterwards.

3.4 Time

3.4.1 Resource Consents

The resource consents were granted non-notified on 13 September 2005, 15 weeks after that the application was submitted.

3.4.2 Building and other consents

Not applicable.

3.4.3 Final Design Time

The final design and construction drawings for the bypass were undertaken in 8 months with the stormwater design being a part of that design process.

3.4.4 Construction

It took 6 months for the main drainage works (part of conveyance and attenuation) and outlet to gully.

It will take 2 years to complete the whole roading job, including completion of stormwater conveyance and collection.

3.4.5 Operation and maintenance

i. Life expectancy prior to major works

   Life expectancy prior to major works is expected be of 50 years with minor maintenance works.

ii. Life expectancy for renewal

   The life expectancy for renewal is expected greater than 50 years.